| AD NUMBER |
| --- |
| AD305632 |
| CLASSIFICATION CHANGES |
| TO: unclassified |
| FROM: confidential |
| LIMITATION CHANGES |
| TO:<br>Approved for public release, distribution unlimited |
| FROM:<br>Distribution authorized to U.S. Gov't. agencies and their contractors; Administrative/Operational Use; JUN 1958. Other requests shall be referred to Army Chemical Warfare Laboratory, Edgewood Arsenal, MD 21010. |
| AUTHORITY |
| dpg, d/a ltr, 24 aug 1981; dpg, d/a ltr, 24 aug 1981 |

AD- 305632

SECURITY REMARKING REQUIREMENTS

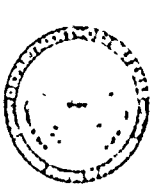
DOD 5200.1-R, DEC 78

REVIEW ON 28 JUN 78

THIS REPORT HAS BEEN DELIMITED AND CLEARED FOR PUBLIC RELEASE UNDER DOD DIRECTIVE 5200 20 AND RESTRICTIONS ARE IMPOSED UPON USE AND DISCLOSURE.

DISTRIBUTION STATEMENT A

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.



CONFIDENTIAL

CWL TECHNICAL MEMORANDUM 33-13

# A SERIES OF STATIC AND DYNAMIC TESTS OF SINGLE BIS AND VX-FILLED 155-MM. SHELL, EQUIPPED WITH AGENT TO BURSTER RATIOS OF 2/1 AND 18/1, AND DETONATED ON THE GROUND AND AT HEIGHTS OF 25 and 50 FT. (U)





by

Dwight H. Shaw
13 June 1958



"The information in this memorandum is issued for temporary or limited use only, and may be superseded."

Directorate of Development
U.S. Army Chemical Warfare Laboratories
Army Chemical Center, Maryland

CONFIDENTIAL

TABLE OF CONTENTS

CWL Technical Memorandum 33-13
A Series of Static and Dynamic Tests of a Single Bis and VX-Filled 155-mm. Shell, Equipped with Agent/Burster Ratios of 2/1 and 18/1, and Detonated on the Ground and at Heights of 25 and 50 ft. (U)

Dwight M. Shaw
Dwight M. Shaw
Author

Submitted by:

Robert M. Black
Robert M. Black
Chief, Planning & Evaluation Br.

Project No.: 4-04-15-032-04

Approval Recommended:

Charles E. Miller
CHARLES E. MILLER
Chief, Test Division

Notebook No.: Test Division Field Test Folders: 1781 through 1801. DPG Field Test Folders: 354-B1 and B2, 355-E1, E2, F1 through F5, G2 and G3.

APPROVED:

R. D. Chapman
R. D. CHAPMAN
Colonel, CmlC
Director of Development

Date Started: 20 February 1957
Date Completed: 23 May 1958

Typed: 5 December 1958

## ABSTRACT

(U) Object.

The object of project 4-04-15-032-04 is to conduct developmental studies on shells, rockets, land mines, spray tanks, bombs, and bomblets for the dissemination of V agent.

The object of this series of tests is to determine the density and drop-size distributions of ground contamination and liquid impaction of a V agent filled 155-mm. shell.

(C) Results.

1. The total area coverage with respect to ground deposition at a density level of 0.05 g./sq.m. for this munition statically functioned at ground level and equipped with agent/burster ratios of 2/1 and 18/1 was 1,500 and 1,000 sq.m., respectively. The area coverage with respect to vertical impaction for the 2/1 and 18/1 ratios was 1,400 and 800 sq.m., respectively. The total quantity of agent deposited on the grid as ground deposition was approximately 100% of the agent filling weight for each ratio.

2. The total area coverage with respect to ground deposition at a density level of 0.05 g./sq.m. for this munition dynamically functioned at a height of 25 ft. and equipped with an agent/burster ratio of 2/1 ranged from 3,700 to 5,500 sq.m. The total quantity of ground deposition ranged from approximately 80 to 100% of the agent filling weight.

3. The total area coverage with respect to ground deposition at a density level of 0.05 g./sq.m. for this munition statically or dynamically functioned at a height of 50 ft. and equipped with agent/burster ratios of 2/1 and 18/1 ranged from 3,800 to 7,700 sq.m. and 2,200 to 6,500 sq.m., respectively. The area coverage with respect to vertical impaction for the 2/1 and 18/1 ratios ranged from 12,800 to 13,000 sq.m. and 3,600 to 8,900 sq.m., respectively. The total quantity of ground deposition ranged from 70 to 100% of the agent filling weight for each ratio.

# A SERIES OF STATIC AND DYNAMIC TESTS OF SINGLE BIS AND VX-FILLED 155-MM. SHELL, EQUIPPED WITH AGENT TO BURSTER RATIOS OF 2/1 AND 18/1, AND DETONATED ON THE GROUND AND AT HEIGHTS OF 25 AND 50 FT. (U)

## I. INTRODUCTION.

### A. (U) Object.

The object of project 4-04-15-032-04 is to conduct developmental studies on shells, rockets, land mines, spray tanks, bombs, and bonblets for the dissemination of V agent.

The object of this series of tests is to determine the density and drop-size distributions of ground contamination and liquid impaction of a V agent filled 155-mm. shell.

### B. (U) Authority.

This investigation was authorized under project 4-04-15-032-04, V-agent Munitions, established 12 December 1957 (CCTC Item 3388).

## II. (U) HISTORICAL.

Among the test programs established to conduct developmental studies on the dissemination of V-agent from shell, rockets, land mines, spray tanks, bombs, and bomblets is the 155-mm. shell which is outlined in this report. These tests were conducted at Army Chemical Center and Dugway Proving Ground for the purpose of determining the efficiency of agent dissemination from a VX and VX simulant-filled 155-mm. shell when equipped with agent/burster ratios of 2/1 and 18/1 and statically and dynamically functioned at various heights. This test program is continuing since the presently conducted tests have not been completely evaluated at this time. These additional results will be published at a later date as an addendum to this report.

## III. EXPERIMENTAL.

### A. (U) Munition.

For each test, conducted at the Army Chemical Center M field test installation and at Dugway Proving Grounds, a single 155-mm. shell was filled with VX or VX simulant [bis-compound bis(2-ethyl hexyl) hydrogen phosphite]; containing tetrytol as a burster; agent/burster ratios of 2/1 and 18/1; and statically or dynamically functioned on the ground and at heights of 25 and 50 ft. The exact agent filling weight, burster weight, and agent to burster ratios for each munition are given in table 1.

### B. (U) Procedure.

All of the ground and 50 ft. air burst tests, conducted at Army Chemical Center, were statically functioned on a 500-yd. square horizontal grid with the exception of field test 1792-A which was conducted on a 1,000-yd. circular grid. The sampling equipment was emplaced on the grid as described in the test directive and amendments for field tests 1781 through 1801, given in appendix A, and also as described in Standard Plan of Test No. 11 for field test 1792A.

All of the air burst tests, conducted at Dugway Proving Ground, were functioned dynamically from a field piece located approximately 100 yd. upwind from the grid into a plate glass target suspended at heights of 25 and 50 ft. The tests were conducted as specified in DPG Test Plan No. 354, Phase B, and No. 355, Phases E, F and G.

C. (U) Results.

1. General.

A summary of the operational data of each test is given in table 1. The results of each test that had agent flashing are not included since a memorandum will be issued summarizing all data with respect to agent stability on detonation.

Table 1

Summary of Trials

| Field test | Place of test | Date & time | Weight of agent | Weight of pure agent | Weight of burster | Agent/ burster ratio | Burst height | Detonation | Agent |
|---|---|---|---|---|---|---|---|---|---|
| | | | g. | g. | | | ft. | | |
| 1781 | ACC | 8 Mar 1957, 1225hr. | 2,835 | 2,835 | 1,234 | 2/1 | gr. | Static | Bis |
| 355 E1 | DPG | 19 Dec 1957,0600hr. | 2,549 | 2,192 | 1,191 | 2/1 | 25 | Dynamic | Bis |
| E1 | DPG | 19 Dec 1957,0600hr. | 2,549 | 2,192 | 1,191 | 2/1 | 25 | Dynamic | VX |
| E2 | DPG | 14 Jan 1958,1904hr. | 2,549 | 2,192 | 1,191 | 2/1 | 25 | Dynamic | VX |
| F1 | DPG | 21 Jan 1958,2142hr. | 2,549 | 2,192 | 1,191 | 2/1 | 50 | Dynamic | VX |
| F2 | DPG | 3 Feb 1958, 1949hr. | 2,549 | 2,192 | 1,191 | 2/1 | 50 | Dynamic | VX |
| F3 | DPG | 19 Mar 1958,1850hr. | 2,549 | 2,192 | 1,191 | 2/1 | 50 | Dynamic | VX |
| F4 | DPG | 27 Mar 1958,0751hr. | 2,549 | 2,192 | 1,191 | 2/1 | 50 | Dynamic | VX |
| F5 | DPG | 15 Apr 1958,0755hr. | 2,549 | 2,192 | 1,191 | 2/1 | 50 | Dynamic | VX |
| 354 B1 | DPG | 9 Apr 1957, 0615hr. | 2,455 | 2,455 | 1,191 | 2/1 | 50 | Dynamic | Bis |
| B2 | DPG | 11 Apr 1957,0641hr. | 2,455 | 2,455 | 1,191 | 2/1 | 50 | Dynamic | Bis |
| 1784 | ACC | 18 Mar 1957,1255hr. | 2,835 | 2,835 | 1,234 | 2/1 | 50 | Static | Bis |
| 1785 | ACC | 25 Mar 1957,1234hr. | 2,722 | 2,722 | 1,234 | 2/1 | 50 | Static | Bis |
| 1783 | ACC | 18 Mar 1957,1025hr. | 3,289 | 3,289 | 188 | 18/1 | gr. | Static | Bis |
| 1790 | ACC | 21 Mar 1957,1130hr. | 3,402 | 3,402 | 188 | 18/1 | 50 | Static | Bis |
| 1791 | ACC | 27 Mar 1957,1415hr. | 3,289 | 3,289 | 188 | 18/1 | 50 | Static | Bis |
| 1792A | ACC | 3 Nov 1957,1135 hr. | 3,400 | 2,754 | 140 | 18/1 | 50 | Static | Bis |
| 355 G2 | DPG | 18 Mar 1958,1919hr. | 3,473 | 2,987 | 186 | 18/1 | 50 | Dynamic | VX |
| G3 | DPG | 16 Apr 1958,0929hr. | 3,473 | 2,987 | 186 | 18/1 | 50 | Dynamic | VX |

2. Meteorological Data.

A summary of the meteorological data that was obtained from burst to cloud passage for each test is given in table 2.

Table 2

Meteorological Data

| Field test | Average wind speed | Average wind direction | Temperature gradient | | Temperature | |
|---|---|---|---|---|---|---|
| | | | 2 m.-0.3 m. | 4 m.-0.5 m. | Surface | Air |
| | m.p.h. | deg. | °F. | °F. | °F. | °F. |
| 1781 | 3 | 192 | -2.8 | -2.2 | 54 | 37 |
| 355 E1 | 6 | 144 | +0.5 | +2.5 | 22 | 25 |
| E1 | 6 | 144 | +0.5 | +2.5 | 22 | 25 |
| E2 | 8 | 125 | +0.5 | +1.0 | 28 | 30 |
| F1 | 7 | 141 | +0.7 | +1.7 | 20 | 21 |
| F2 | 14 | 142 | +0.5 | +0.8 | 38 | 40 |
| F3 | 7 | 135 | +1.2 | +2.7 | 46 | 49 |
| F4 | 9 | 115 | -0.1 | -0.7 | 39 | 37 |
| F5 | 5 | 112 | -0.3 | -1.3 | 49 | 51 |
| 354 B1 | 6 | 130 | +0.9 | +1.3 | 36 | 37 |
| B2 | 4 | 160 | -0.6 | -1.3 | 45 | 43 |
| 1784 | 8 | 86 | -1.2 | -1.2 | 46 | 44 |
| 1785 | 10 | 86 | -1.4 | -1.4 | 44 | 42 |
| 1783 | 2 | 240 | -1.0 | -0.8 | 50 | 52 |
| 1790 | 9 | 320 | -1.6 | -2.1 | 50 | 45 |
| 1791 | 7 | 16 | -1.5 | -1.7 | 42 | 45 |
| 1792A | 13 | 288 | -1.2 | -1.8 | 54 | 49 |
| 355 G2 | 6 | 132 | +0.6 | +1.1 | 41 | 42 |
| G3 | 3 | 85 | 0.0 | -1.6 | 59 | 63 |

IV. DERIVED RESULTS.

A. (U) Ground Deposition.

1. Area Coverage.

The total areas covered by various contamination densities for ground deposition (measured by sampling pans at ACC and by petri dishes at DPG) are given in table 3.

Table 3

Total Area Coverage by Ground Deposition

| Field test | Agent/ burster ratio | Height of burst | Agent | Contamination density (g./sq.m.) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.01 | 0.05 | 0.1 | 0.5 | 1 | 5 | 10 |
| | | ft. | | sq.m. | | | | | | |
| 1781 | 2/1 | gr. | Bis | 3,700 | 1,500 | 1,150 | 640 | 480 | 170 | 60 |
| 355 E1 | 2/1 | 25 | Bis | 23,000 | | 1,900 | 600 | 280 | 0 | |
| E1 | 2/1 | 25 | VX | 10,000 | 3,700 | 2,200 | 650 | 380 | 110 | 0 |
| E2 | 2/1 | 25 | VX | 11,000 | 4,700 | 3,200 | 1,200 | 640 | 10 | 0 |
| F1 | 2/1 | 50 | VX | 17,300 | 5,600 | 3,680 | 990 | 270 | 0 | 0 |
| F2 | 2/1 | 50 | VX | 20,900 | 6,500 | 3,900 | 910 | 230 | 0 | 0 |
| F3 | 2/1 | 50 | VX | 14,560 | 5,700 | 3,700 | 870 | 290 | 0 | 0 |
| F4 | 2/1 | 50 | VX | 11,670 | 5,000 | 3,400 | 900 | 400 | 0 | 0 |
| F5 | 2/1 | 50 | VX | 10,800 | 5,700 | 3,800 | 1,040 | 560 | 0 | 0 |
| 354 B1 | 2/1 | 50 | Bis | 11,000 | 4,400 | 2,700 | 650 | 330 | 0 | 0 |
| B2 | 2/1 | 50 | Bis | 10,300 | 3,800 | 1,900 | 700 | 400 | 0 | 0 |
| 1784 | 2/1 | 50 | Bis | 18,500 | 7,700 | 5,100 | 920 | 215 | 0 | 0 |
| 1785 | 2/1 | 50 | Bis | 12,600 | 4,600 | 3,100 | 1,180 | 370 | 0 | 0 |
| 1783 | 18/1 | gr. | Bis | 1,700 | 990 | 760 | 370 | 270 | 140 | 90 |
| 1790 | 18/1 | 50 | Bis | 5,750 | 3,600 | 2,900 | 1,450 | 820 | 65 | 0 |
| 1791 | 18/1 | 50 | Bis | 4,900 | 2,250 | 1,550 | 820 | 520 | 150 | 20 |
| 1792A | 18/1 | 50 | Bis | 12,640 | 3,810 | 2,140 | 930 | 590 | 100 | 0 |
| 355 G2 | 18/1 | 50 | VX | 17,500 | 6,500 | 4,200 | 1,450 | 700 | 0 | 0 |
| G3 | 18/1 | 50 | VX | 8,200 | 4,300 | 3,100 | 1,100 | 590 | 80 | 0 |

2. Maximum Density.

The maximum recorded contamination density for ground deposition and its location for each field test is given in table 4.

Table 4

Maximum Recorded Contamination Density

| Field test | Density | Distance from burst |
|---|---|---|
| | g./sq.m. | yd. |
| 1781 | 24.5 | 5 |
| 355 E1 | 1.1 | 60 |
| E1 | 5.6 | 18 |
| E2 | 8.4 | 31 |
| F1 | 1.7 | 45 |
| F2 | 1.2 | 30 |
| F3 | 2.0 | 55 |
| F4 | 2.1 | 30 |
| F5 | 4.7 | 37 |
| 354 B1 | 3.1 | 24 |
| B2 | 3.3 | 24 |
| 1784 | 1.5 | 50 |
| 1785 | 2.4 | 80 |
| 1783 | 42.9 | 5 |
| 1790 | 6.8 | 50 |
| 1791 | 13.7 | 30 |
| 1792A | 6.1 | 40 |
| 355 G2 | 2.6 | 79 |
| G3 | 5.0 | 37 |

3. Weight Recovery.

The ground deposition data was converted to a weight of agent deposited on the ground. These values are given in table 5 for the indicated distance downwind of the cloud. Although in one case the agent return is stated as being greater than 100%, it is within the experimental error for the conditions of field testing and the significance of the figure implies that 100% of the agent disseminated was accounted for by ground deposition.

Table 5

Quantity of Agent Deposited on the Grid as Ground Deposition From Burst to Indicated Distance Downwind

| Field test | Agent/ burster ratio | Burst height | Agent | Munition's filling weight | Burst to indicated distance downwind(yd.) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 50 | 100 | 200 | 300 | 400 | 600 |
| | | ft. | | g. | | | | % | | |
| 1781 | 2/1 | gr. | Bis | 2,835 | 94 | 96* | | | | |
| 355 E1 | 2/1 | 25 | Bis | 2,192 | 29 | 47 | 66 | 73 | 76 | 79* |
| E1 | 2/1 | 25 | VX | 2,192 | 46 | 71 | 81 | 83 | 84 | 89* |
| E2 | 2/1 | 25 | VX | 2,192 | 85 | 104 | 109* | | | |
| F1 | 2/1 | 50 | VX | 2,192 | 12 | 35 | 68 | 77 | 81 | 86* |
| F2 | 2/1 | 50 | VX | 2,192 | 23 | 42 | 68 | 81 | 88 | 93* |
| F3 | 2/1 | 50 | VX | 2,192 | 32 | 56 | 76 | 81 | 83 | 86* |
| F4 | 2/1 | 50 | VX | 2,192 | 29 | 58 | 80 | 84 | 85 | 86* |
| F5 | 2/1 | 50 | VX | 2,192 | 50 | 76 | 91 | 93 | 94* | |
| 354 B1 | 2/1 | 50 | Bis | 2,455 | 42 | 61 | 73 | 77 | 78* | |
| B2 | 2/1 | 50 | Bis | 2,455 | 56 | 63 | 69 | 71* | | |
| 1784 | 2/1 | 50 | Bis | 2,835 | 9 | 32 | 63 | 75 | 78* | |
| 1785 | 2/1 | 50 | Bis | 2,722 | 4 | 32 | 72 | 82* | | |
| 1783 | 18/1 | gr. | Bis | 3,289 | 97 | 98* | | | | |
| 1790 | 18/1 | 50 | Bis | 3,402 | 19 | 68 | 84 | 86* | | |
| 1791 | 18/1 | 50 | Bis | 3,289 | 44 | 63 | 71* | | | |
| 1792A | 18/1 | 50 | Bis | 3,400 | 52 | 75 | 88 | 92 | 95 | 97* |
| 355 G2 | 18/1 | 50 | VX | 2,987 | 20 | 39 | 75 | 81 | 84 | 87* |
| G3 | 18/1 | 50 | VX | 2,987 | 50 | 67 | 81 | 85 | 87* | |

*Total agent return for a density of 1.0 mg. and greater.

B. (U) Vertical Impaction.

1. Area Coverage.

The total areas covered by various contamination densities for vertical impaction (measured by sampling plates at ACC and by filter paper attached to cylindrical samplers at DPG) are given in tables 6 and 7.

## Table 6

### Total Area Coverage by Vertical Impaction at a Height of 18 in.

| Field test* | Agent/ burster ratio | Height of burst | Agent | Contamination density (g./sq.m.) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.01 | 0.05 | 0.1 | 0.5 | 1 | 5 | 10 |
| | | ft. | | sq.m. | | | | | | |
| 1781 | 2/1 | gr. | Bis | 2,700 | 1,400 | 810 | 310 | 75 | 0 | 0 |
| 355 F1 | 2/1 | 50 | VX | 13,000 | 5,700 | 4,100 | 180 | 0 | 0 | 0 |
| F2 | 2/1 | 50 | VX | 21,000 | 13,000 | 7,400 | 920 | 200 | 0 | 0 |
| F4 | 2/1 | 50 | VX | 10,900 | 8,400 | 5,600 | 450 | 0 | 0 | 0 |
| F5 | 2/1 | 50 | VX | 15,000 | 7,400 | 4,700 | 0 | 0 | 0 | 0 |
| 1784 | 2/1 | 50 | Bis | 21,000 | 13,000 | 9,200 | 3,400 | 1,400 | 0 | 0 |
| 1785 | 2/1 | 50 | Bis | 23,540 | 12,780 | 9,670 | 4,990 | 2,970 | 0 | 0 |
| 1783 | 18/1 | gr. | Bis | 1,470 | 800 | 610 | 270 | 165 | 15 | 5 |
| 1790 | 18/1 | 50 | Bis | 6,160 | 4,100 | 3,320 | 1,900 | 1,300 | 320 | 30 |
| 1791 | 18/1 | 50 | Bis | 4,850 | 3,600 | 2,780 | 900 | 650 | 170 | 50 |
| 1792A | 18/1 | 50 | Bis | 11,950 | 8,850 | 6,400 | 2,800 | 1,900 | 620 | 0 |
| 355 G2 | 18/1 | 50 | VX | 20,000 | 8,400 | 5,800 | 2,100 | 1,200 | 0 | 0 |
| G3 | 18/1 | 50 | VX | 10,000 | 3,600 | 2,800 | 440 | 0 | 0 | 0 |

*Field tests that did not have available data are not listed.

## Table 7

### Area Coverage by Vertical Impaction at a Height of 60 in.

| Field test* | Agent/ burster ratio | Height of burst | Agent | Contamination density (g./sq.m.) | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.01 | 0.05 | 0.1 | 0.5 | 1 | 5 |
| | | ft. | | | | sq.m. | | | |
| 355 F1 | 2/1 | 50 | VX | 21,000 | 13,500 | 8,700 | 1,450 | 300 | 0 |
| F2 | 2/1 | 50 | VX | 33,200 | 17,000 | 8,800 | 1,300 | 450 | 0 |
| F4 | 2/1 | 50 | VX | 19,500 | 8,800 | 5,600 | 700 | 0 | 0 |
| F5 | 2/1 | 50 | VX | 17,500 | 7,900 | 4,700 | 820 | 0 | 0 |
| G2 | 18/1 | 50 | VX | 22,000 | 10,500 | 7,400 | 2,500 | 1,200 | 30 |
| G3 | 18/1 | 50 | VX | 8,800 | 4,700 | 3,000 | 400 | 0 | 0 |

*Field tests that did not have available data are not listed.

2. Weight Recovery.

For each test conducted at DPG, the weight of agent transported beyond 500 yd. was measured by vertically positioned cylindrical filter-paper samplers (size 3-3/4 by 8 in.) at each position on the 500-yd. arc at heights of 1.5, 5, 10, 15, 20, 25 and 30 ft. This quantity of agent measured airborne is given in table 8.

Table 8

Quantity of Agent Airborne 500 yd. From Burst

| Field test* | Agent/ burster ratio | Burst height | Agent | Weight of pure agent filling | Agent recovery | |
|---|---|---|---|---|---|---|
| | | | | | Weight | Fraction of filling |
| | | ft. | | g. | g. | % |
| 355 E1 | 2/1 | 25 | VX | 2,192 | 8 | 0.4 |
| E2 | 2/1 | 25 | VX | 2,192 | 22 | 1.0 |
| F1 | 2/1 | 50 | VX | 2,192 | 28 | 1.3 |
| F2 | 2/1 | 50 | VX | 2,192 | 35 | 1.6 |
| F3 | 2/1 | 50 | VX | 2,192 | 8 | 0.4 |
| F4 | 2/1 | 50 | VX | 2,192 | 10 | 0.4 |
| F5 | 2/1 | 50 | VX | 2,192 | 2 | 0.1 |
| G2 | 18/1 | 50 | VX | 2,987 | 16 | 0.5 |
| G3 | 18/1 | 50 | VX | 2,987 | 3 | 0.1 |

*Field tests that did not have available data are not listed.

C. (U) Particle Size Data.

The particle size data are presently being evaluated for each test conducted at ACC and DPG under this program. The results will be summarized and published in a later report as an addendum to this memorandum.

D. (U) Agent Stability.

Inspection of the motion pictures taken of each test in this Bis and VX-filled 155-mm. shell program, conducted at ACC and DPG, indicate that agent flashing occurred in two out of nine 50 ft. trials with the munition (both statically fired) equipped with a 2/1 agent/burster ratio and two out of seven 50 ft. trials (one static and one dynamic) with the munition equipped with an 18/1 agent/burster ratio. Agent flashing did not occur in the static fired munitions functioned at ground level nor in the dynamic fired munitions functioned at a height of 25 ft. The results of each test that had agent flashing are not included in this report since a memorandum will be issued summarizing all data with respect to agent stability.

V. (C) DISCUSSION.

Sample area coverage curves are given in appendix B (figures 1 through 8) illustrating the change in area coverage when the munition is fired statically and dynamically, filled with VX and VX simulant, equipped with agent/burster ratios of 2/1 and 18/1, and functioned at various heights. These curves have not been adjusted for standard meteorological conditions; however, the wind speed of each test is given on each figure.

A comparison between the area coverage of ground deposition produced by this munition functioned at a height of 50 ft. when equipped with a 2/1 agent/burster ratio (figure 1), indicatesthat there is little difference in the results obtained when detonated statically and dynamically; however, there does appear to be an advantage in functioning the munition, equipped with a 18/1 agent/burster ratio, dynamically for density levels below 1 g./sq.m. (figure 2).

Figure 3 indicates that there is little difference in the area coverage of ground deposition when the munition is filled with VX and VX simulant [bis-compound bis(2-ethyl hexyl) hydrogen phosphite].

Inspection of figures 4 and 5 indicatesthat the optimum height for achieving maximum area coverage for small contamination densities is at some height above 50 ft. for both the 2/1 and 18/1 agent/burster ratios. For high density levels (5 to 10 g./sq.m.) the optimum height appears to be at ground level.

In regard to the 2/1 and 18/1 agent/burster ratios, figures 6 and 7 indicate that there is a slight advantage in equipping the munition with a 2/1 ratio when statically functioned at ground level and at a height of 50 ft. In functioning the munition dynamically, figure 8 indicates that there is essentially no difference in the area coverage of ground deposition.

## APPENDIX A

## TEST DIRECTIVE AND AMENDMENTS, FIELD TESTS 1781 THROUGH 1801

TEST DIVISION
DIRECTORATE OF DEVELOPMENT
CHEMICAL WARFARE LABORATORIES
Army Chemical Center, Maryland

TEST DIRECTIVE

FIELD TESTS 1781 THROUGH 1801

Static Tests of Single Bis-Filled 155-mm Shell Equipped with Agent to Burster Ratios of 2/1, 10/1, and 30/1 and Detonated on the Ground and at Heights of 50 and 100 ft.

CMLRD-CW-D(T) 20 February 1957

I. OBJECT.

The object of these tests is:

A. To establish the effect of the agent to burster ratio on the dissemination of V-agent simulant when the projectile is air and ground burst.

B. To determine if V-agent projectiles of optimum agent to burster ratio as determined by these tests can be assessed at Carroll Island.

II. AUTHORITY.

Project 4-04-15-028, Gas Artillery Shell, Job Control No. 7-165. These tests were requested in Munitions Division's Work Order dated

III. METEOROLOGICAL REQUIREMENTS.

No precipitation; wind speed at 2 m. height, between 4 and 12 m.p.h.

IV. AGENT.

Bis-compound bis(2-ethyl hexyl) hydrogen phosphite .

V. MUNITION.

A. Munitions Detonated at Ground Level.

Each munition will be a single 155-mm. shell arranged for static firing. The details of each munition's description are given in the following table:

| Field test | Approx. weight of agent | Approx. weight of burster | Type burster | Agent to burster ratio |
|---|---|---|---|---|
| | g. | g. | | |
| 1781 | 2800 | 1400 | tetrytol | 2/1 |
| 1782 | 3100 | 310 | tetrytol | 10/1 |
| 1783 | 4100 | 140 | tetrytol | 30/1 |

B. Munitions Detonated at a 50-ft. Height.

Each munition will be a single 155-mm. shell arranged for static firing at 50 ft. above ground level. The details of each munitions description are given in the following table:

| Field test | Approx. weight of agent | Approx. weight of burster | Type burster | Agent to burster ratio |
|---|---|---|---|---|
| | g. | g. | | |
| 1784-1786 | 2800 | 1400 | tetrytol | 2/1 |
| 1787-1789 | 3100 | 310 | tetrytol | 10/1 |
| 1790-1791 | 4100 | 140 | tetrytol | 30/1 |

C. Munitions Detonated at a 100-ft. Height.

Each munition will be a single 155-mm. shell and arranged for functioning at 100 ft. above ground. The details of each munition's description are given in the following table:

| Field test | Approx. weight of agent | Approx. weight of burster | Type burster | Agent to burster ratio |
|---|---|---|---|---|
| | g. | g. | | |
| 1793-1795 | 2800 | 1400 | tetrytol | 2/1 |
| 1796-1798 | 3100 | 310 | tetrytol | 10/1 |
| 1799-1801 | 4100 | 140 | tetrytol | 30/1 |

VI. PLAN OF TEST.

A. Procedure.

Each of the tests functioned at ground level and at the 50-ft. height will be conducted at M field on a sampling grid which will be laid out

as described in diagram A. The munitions which will be airburst at the 50-ft. height will be suspended between poles on a cable and will be fixed in such a manner that its position simulates the arrival angle of the munition when fired.

The munitions to be functioned at the 100-ft. height will be positioned in the same manner as those detonated at the 50-ft. height. These tests, however, will be conducted at the Aberdeen Proving Grounds. As much of the sampling grid described in diagram A will be used as space will permit at the Aberdeen facility.

If the tests of munitions detonated at the 50-ft. height indicate a decrease in area coverage as compared to the ground detonated munitions, the tests at a higher altitude will be cancelled.

B. Chemical Data.

1. Liquid Sampling.

Sampling pans (393) utilizing hexylene glycol as an absorbent will be positioned on a level surface of the ground at each position, as shown in diagram A. The method of analysis will be the TNB method.

2. Impaction Sampling.

Vertical plates (184) at the 18-in. height will be positioned as shown in diagram A.

3. Particle Spectrum Sampling.

Vertical (184) and horizontal (184) slides will be positioned on the grid as shown in diagram A. The vertical slides will be positioned at the 18-in. height.

4. Analysis of Agent Filling.

A 10-ml. sample of the agent in each munition will be submitted to Chemical Test Branch for agent purity examination. If this is not feasible then a sample of the filling batch will be submitted.

C. Meteorological Data.

1. Macrometeorological Observations.

Observational data (cloud height, type and coverage, air temperature, relative humidity, condition of terrain and precipitation record for previous 24 hr.) will be submitted on standard forms. Observations will be made at the test site 5 min. prior to and immediately after the test.

2. Micrometeorological Data.

The wind tower will be used to obtain wind speeds up to 100 ft. for all airburst trials. In addition the 2-m. wind speed, 2-m. wind direction, surface temperature and temperature gradient (2 m.-0.3 m. and 4 m.-0.5 m.) will be measured. All data should be measured on instruments with continuous recorders and as near the center of the grid as practicable.

D. Photographic Data.

1. Still Photographs.

Still photographs only will be taken of the munitions suspended above the ground and of the cloud of all munitions after detonation.

2. Motion Pictures.

High speed motion pictures (1,700 f./sec.) will be taken of the burst at a position as close to the burst as practicable. Standard motion pictures (64 f./sec.) in color, or black and white, as the lighting permits, will be taken on both upwind and cross-wind positions of the cloud travel at a distance of approximately 150 yd.

E. Operational Data.

The test engineer will submit a written report to include the following:

1. Field test number.

2. Date and time of test.

3. Exact weight of agent and explosive.

4. All changes in test procedure from that called for in the test directive.

5. Description of munition functioning from visual observations, including any irregularities.

6. Careful description of crater where applicable and fragments recovered, including dimensions. This phase requires special attention.

7. A complete description of all equipment malfunctioning or damage.

VII. RESPONSIBILITIES.

A. The requesting agency will supply all munitions or equipment (complete) to be tested.

B. Chemical Test Branch, Test Division, will perform all necessary chemical analyses and submit the results with all pertinent information concerning the results to Planning & Evaluation Branch.

C. Field Operations Branch, Test Division, will supply all necessary chemical sampling and meteorological equipment, set up and maintain field, perform all necessary instrumentation, provide test engineers and other necessary personnel, conduct the test, provide auxiliary personnel, equipment and services as necessary and submit the data to Planning & Evaluation Branch.

D. Planning and Evaluation Branch, Test Division, will evaluate the data and results and submit a written report to the requesting agency.

E. Mr. James E. Norton, extension 6119, is the Munitions Division project engineer and the tests will be coordinated through him.

Concurred in:

H L. Gotoff
Harold L. Gotoff
Chief, Field Operations Br.

Submitted by:

for Scott D. Thayer
Dwight M. Shaw

Concurred in:

Abraham Koblin
Abraham Koblin
Chief, Chemical Test Br.

Recommending approval:

for Scott D. Thayer
Frederick L. Horning
Chief, Data Section
Planning & Evaluation Br.

APPROVED:

Scott D. Thayer
SCOTT D. THAYER
Chief, Planning & Evaluation Branch

UNCLASSIFIED

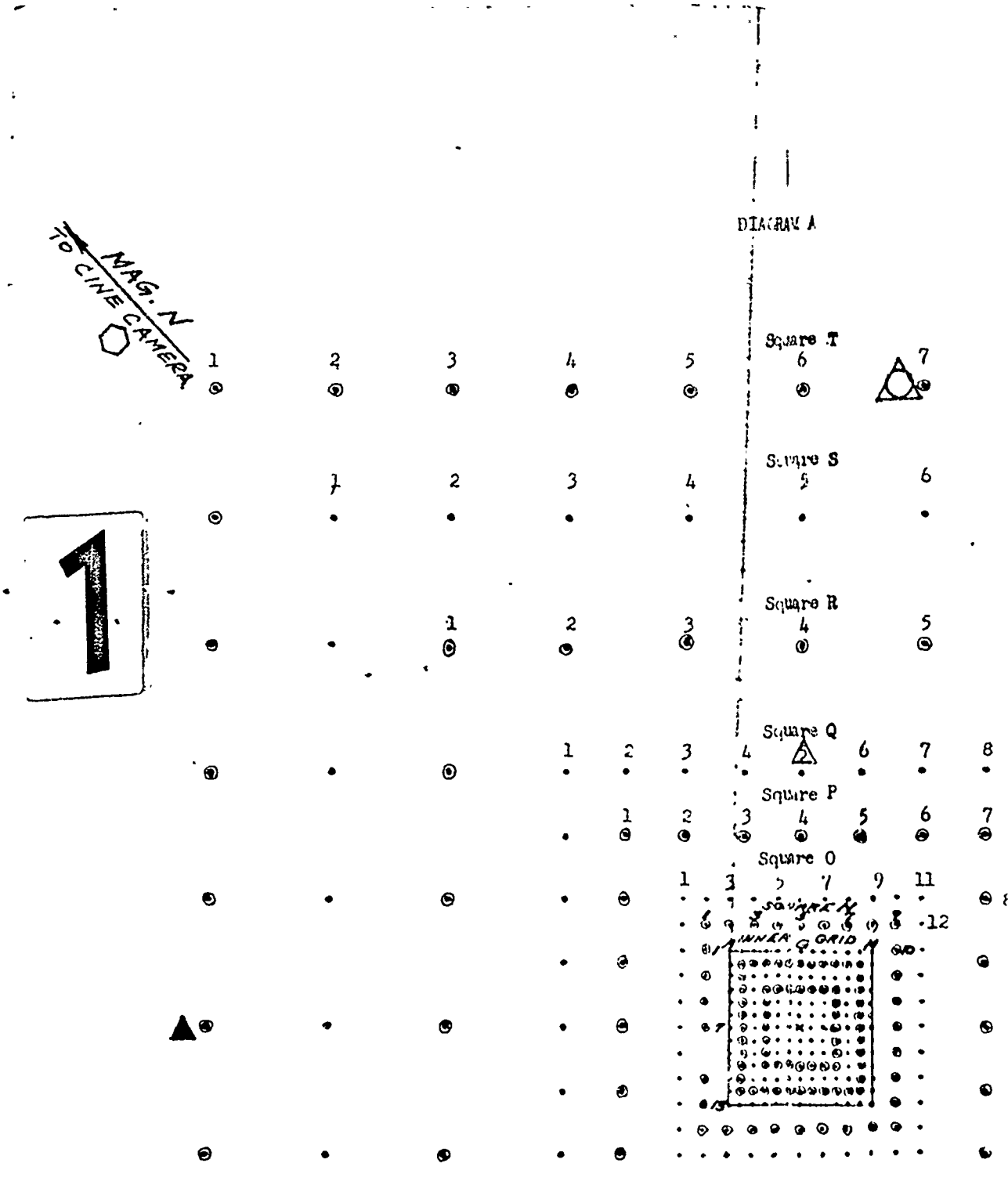
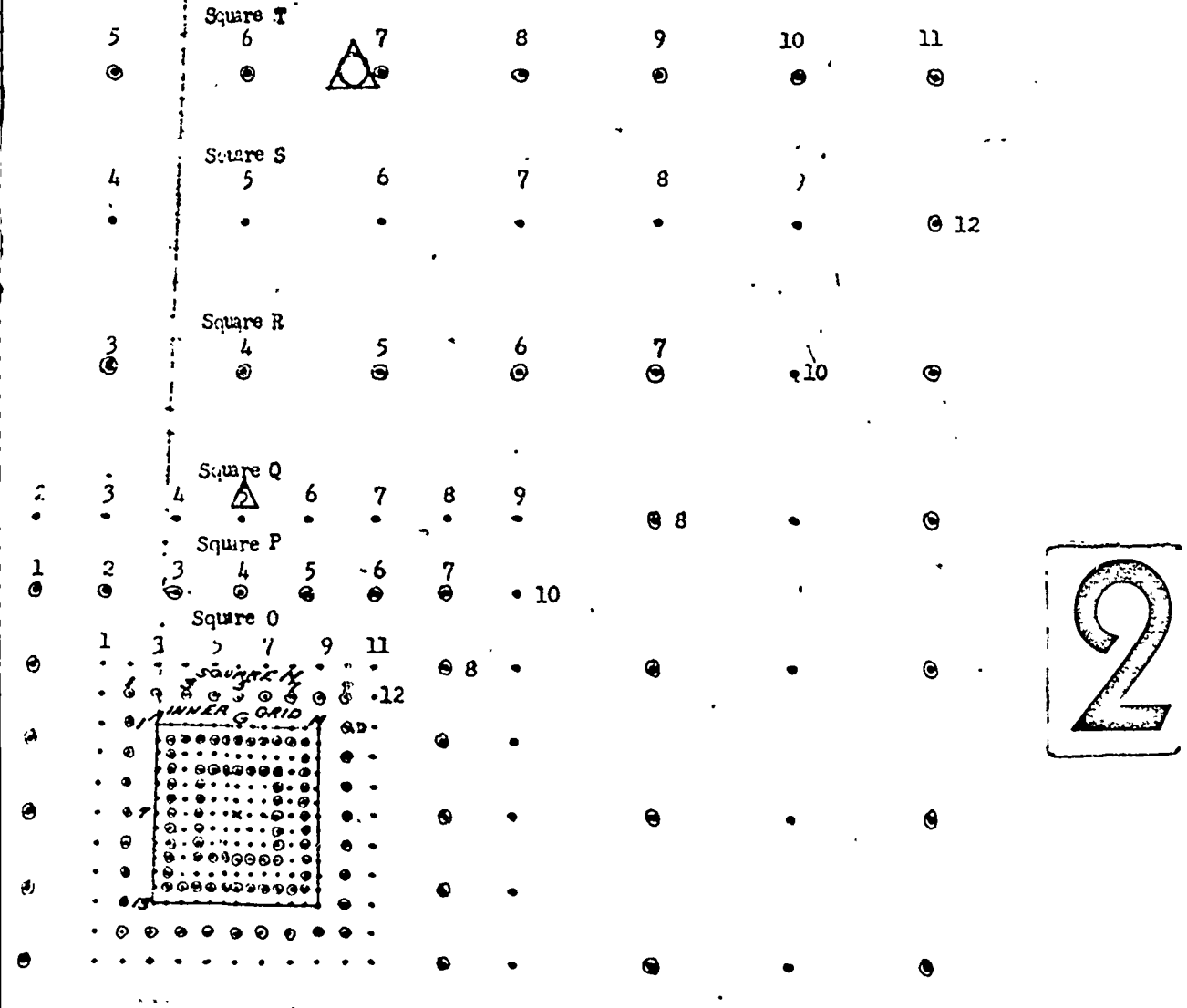
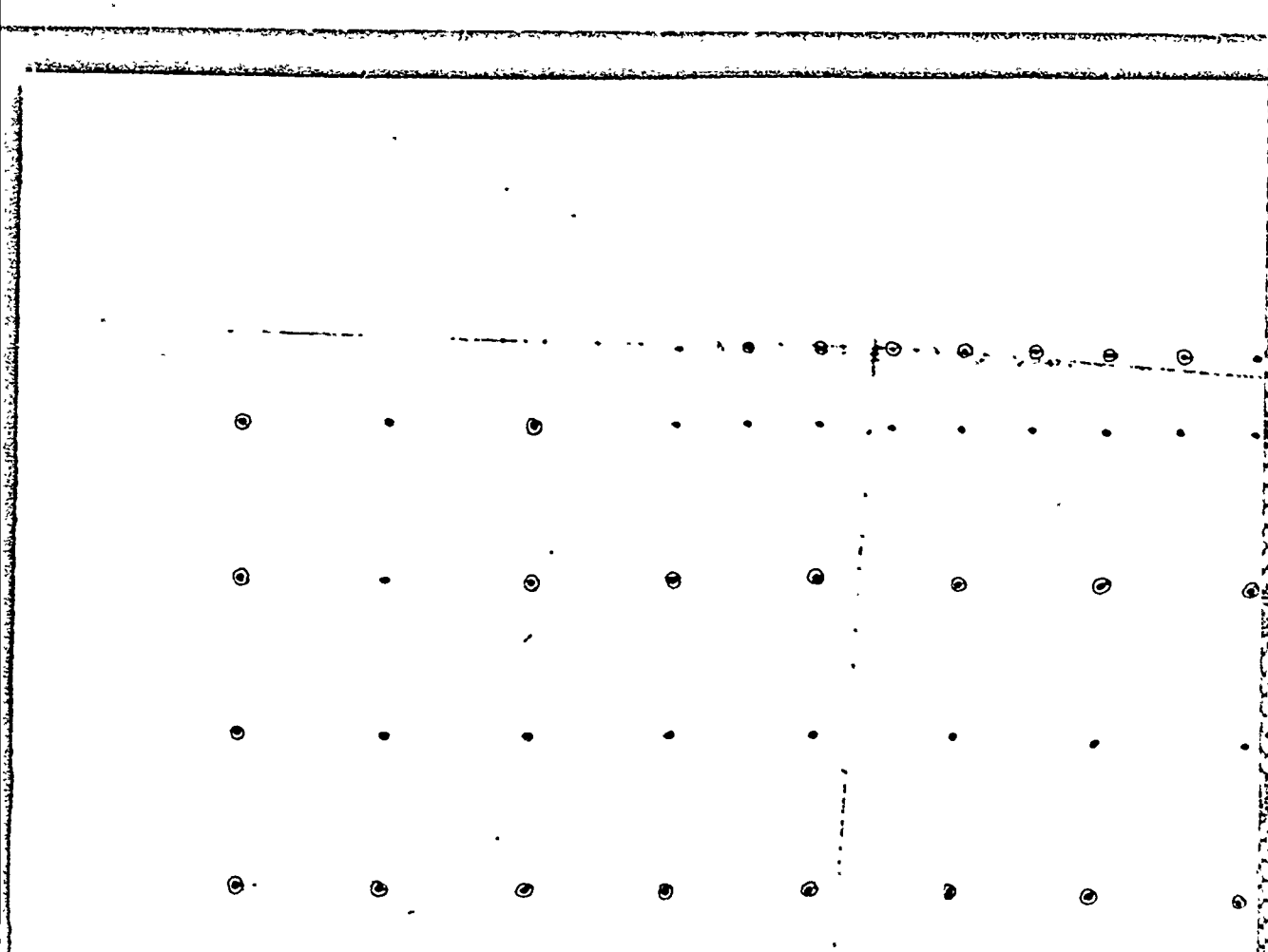


DIAGRAM A
MAG. N
TO CINE CAMERA
Square T
Square S
Square R
Square Q
Square P
Square O
1
2
3
4
5
6
7
8
9
10
11
12
INNER GRID

DIAGRAM A


Square T
5
6
7
8
9
10
11
Square S
4
5
6
7
8
12
Square R
3
4
5
6
7
10
Square Q
3
4
6
7
8
9
8
Square P
1
2
3
4
5
6
7
10
Square O
1
3
9
11
8
12
INNER GRID

2



3

SCALE

1 in. = 50 yd.

LEGEND

x - Grid center (5-level Wind Recorder)

. - Sampling pans

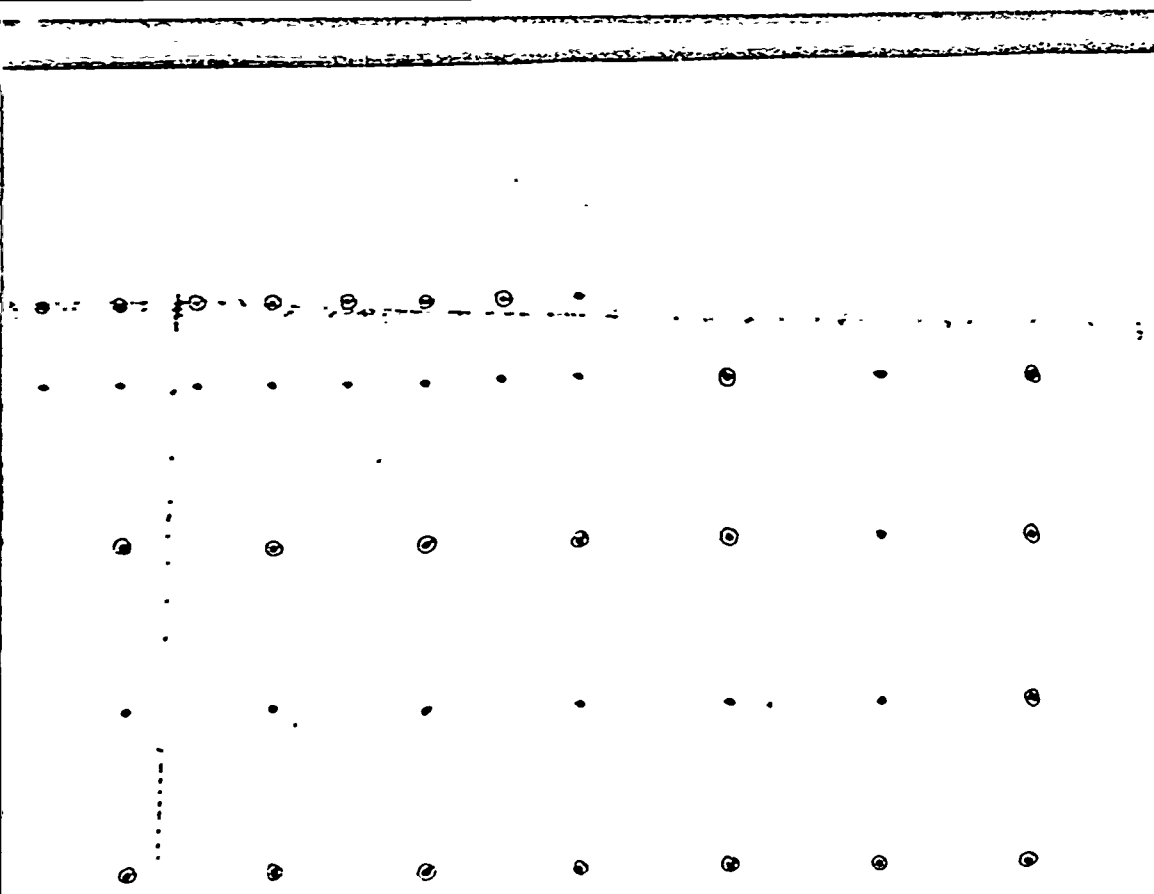
○ - Horizontal and vertical slides
vertical plates

△ Pi-Speed Camera

T.G.Mast

⬡ Cine-Camera (64 fr/sec)

▲ 100 ft. Wind Mast



SCALE

1 in. = 50 yd.

POSITION SPACING

Burst to 30 yd. - 5 yd.

30 yd. to 50 yd. - 10 yd.

50 yd. to 100 yd. - 25 yd.

100 yd. to 250 yd. - 50 yd.

4

(2)

TEST DIVISION
DIRECTORATE OF DEVELOPMENT
CHEMICAL WARFARE LABORATORIES
Army Chemical Center, Maryland

CMLRD-CW-D(T) 5 March 1957

AMENDMENT I

Test Directives for

Field Tests 1781 through 1801
Field Tests 1802 through 1822
Field Tests 1823 through 1846 [illegible]

The directive is amended as follows:

VI. PLAN OF TEST.

A. Procedure.

Each of the tests functioned at ground level will be conducted at M field on a sampling grid which will be laid out as described in diagram A. The tests functioned at the 50 ft. height will be conducted at H field on a sampling grid which will be laid out as shown in diagram B. (Note: The change in grid sampling from A is as follows: Only the sampling pan positions are changed, the slide and plate positions will remain the same. The inner grid will have sampling pans only at those positions which have plates and slides with the addition of 4 positions spaced 10 yd. apart at the corners of a square centered immediately below the munition, square O will have 5 yd. spacing between pans (not 10 yd.), square P will have 5 yd. spacing between pans (not 25 yd.), and square Q will have 12.5 yd. spacing between pans (not 25 yd.)).

B. Chemical Data.

After the words "diagram A" add "or diagram B, as appropriate".

Amendment I to test directives, F. T. 1781 through 1846.
(continued)

Concurred in:

Harold L. Gotoff
Chief, Field Operations Branch

Submitted by:

Frederick L. Horning

Concurred in:

Abraham Koblin
Chief, Chemical Test Branch

Recommending approval:

Scott D. Thayer
Chief, Planning & Evaluation Branch

APPROVED:

CHARLES E. MILLER
Chief, Test Division

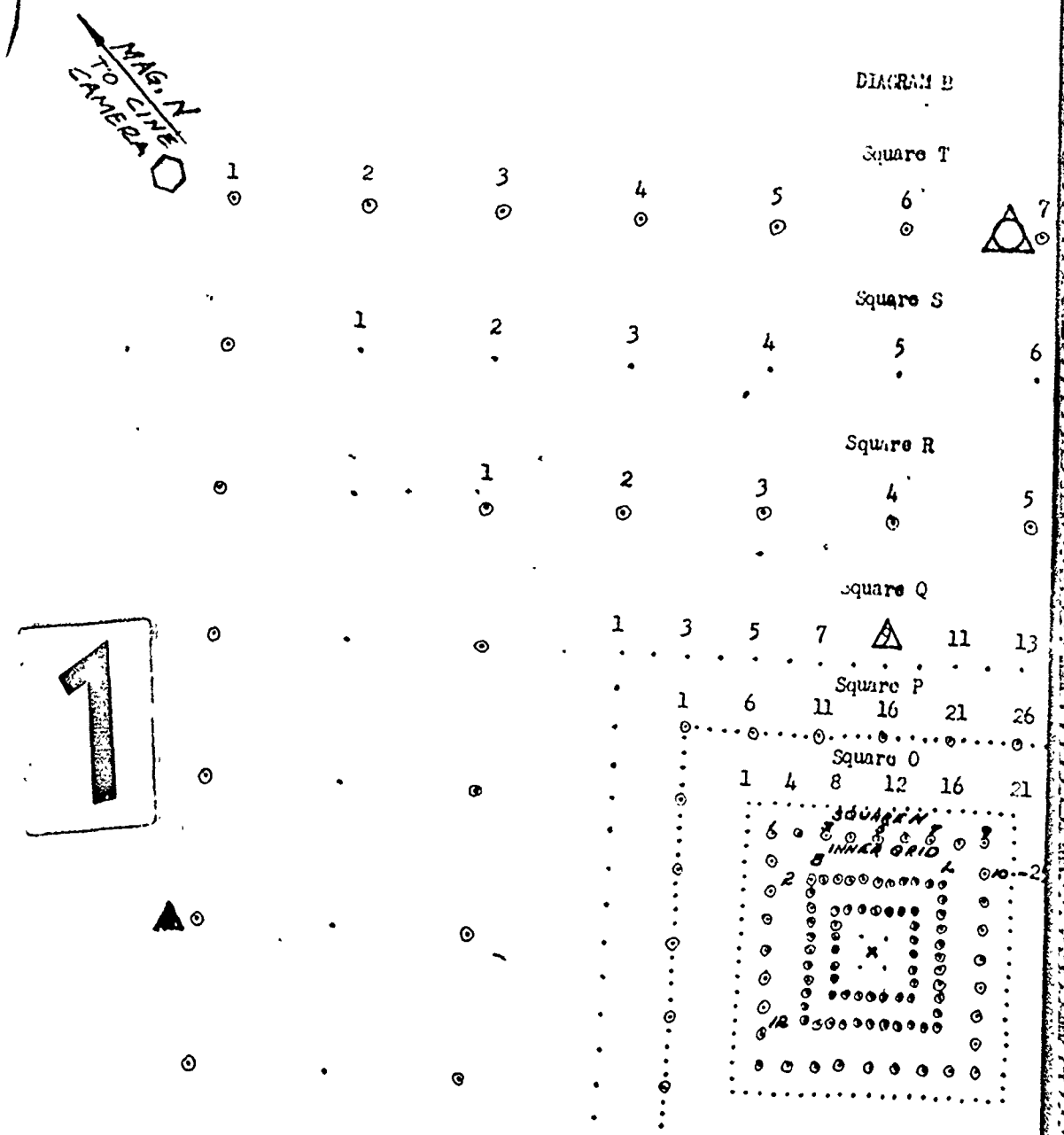
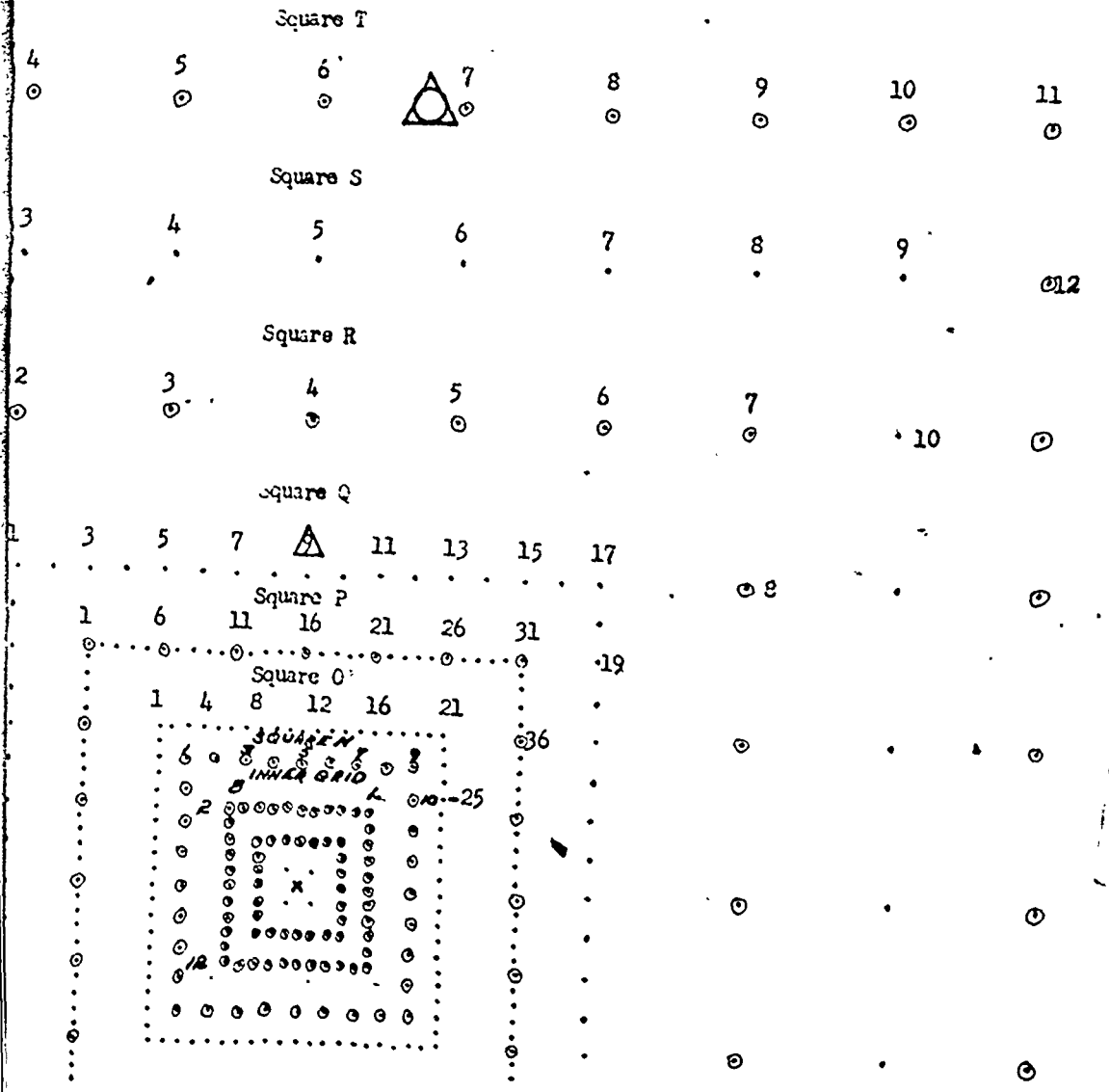
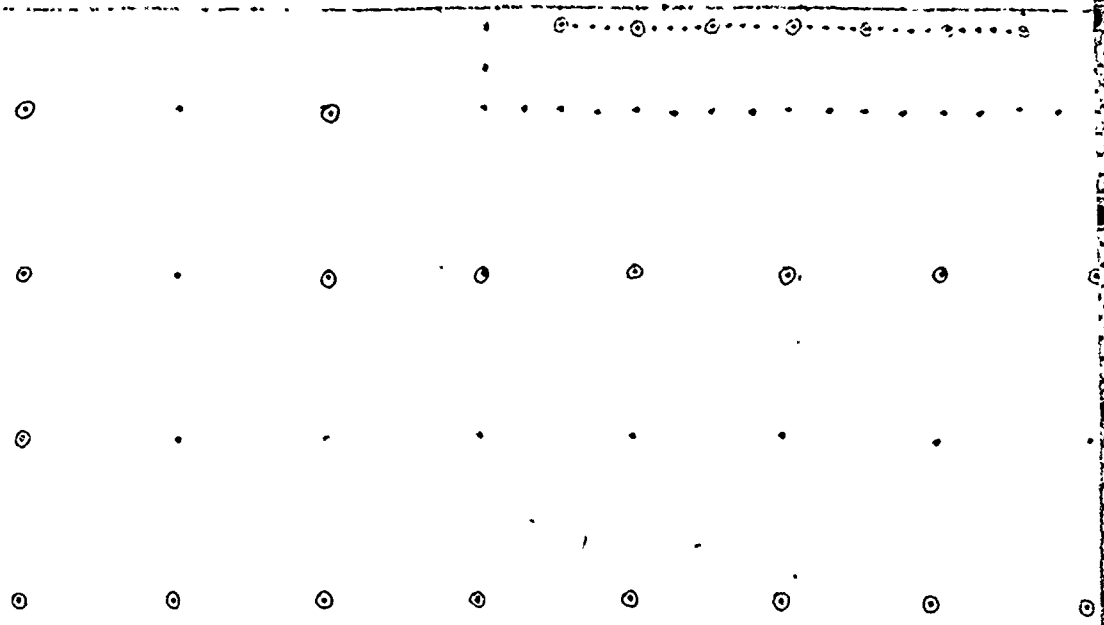

MAG. N
TO CINE CAMERA
DIAGRAM B
Square T
1
2
3
4
5
6
7
Square S
1
2
3
4
5
6
Square R
1
2
3
4
5
Square Q
1
3
5
7
11
13
Square P
1
6
11
16
21
26
Square O
1
4
8
12
16
21
INNER GRID
1
2
25

DIAGRAM B


Square T
4
5
6
7
8
9
10
11
Square S
3
4
5
6
7
8
9
12
Square R
2
3
4
5
6
7
10
Square Q
1
3
5
7
11
13
15
17
Square P
1
6
11
16
21
26
31
19
Square O
1
4
8
12
16
21
36
25



SCALE

1 in. = 50 yd.

LEGEND

x - Grid center (5-level Wind Recorder)

. - Sampling pans

O - Horizontal and vertical slides
vertical plates

Pans only at: F6, H6, F8, H8

Pans, plates and slides at:
B2, C2, D2, E2, F2, G2, H2, I2, J2, K2, L2
B3, L3, B4, D4, E4, F4, G4, H4, I4, J4, L4,
B5, D5, J5, L5, B6, D6, J6, L6, B7, D7, J7,
L7, B8, D8, J8, L8, B9, D9, J9, L9, B10,
D10, E10, F10, G10, H10, I10, J10, L10, B11,
L11, B12, D12, E12, F12, G12, H12, I12, J12,
L12.

△ Hi-Speed Camera

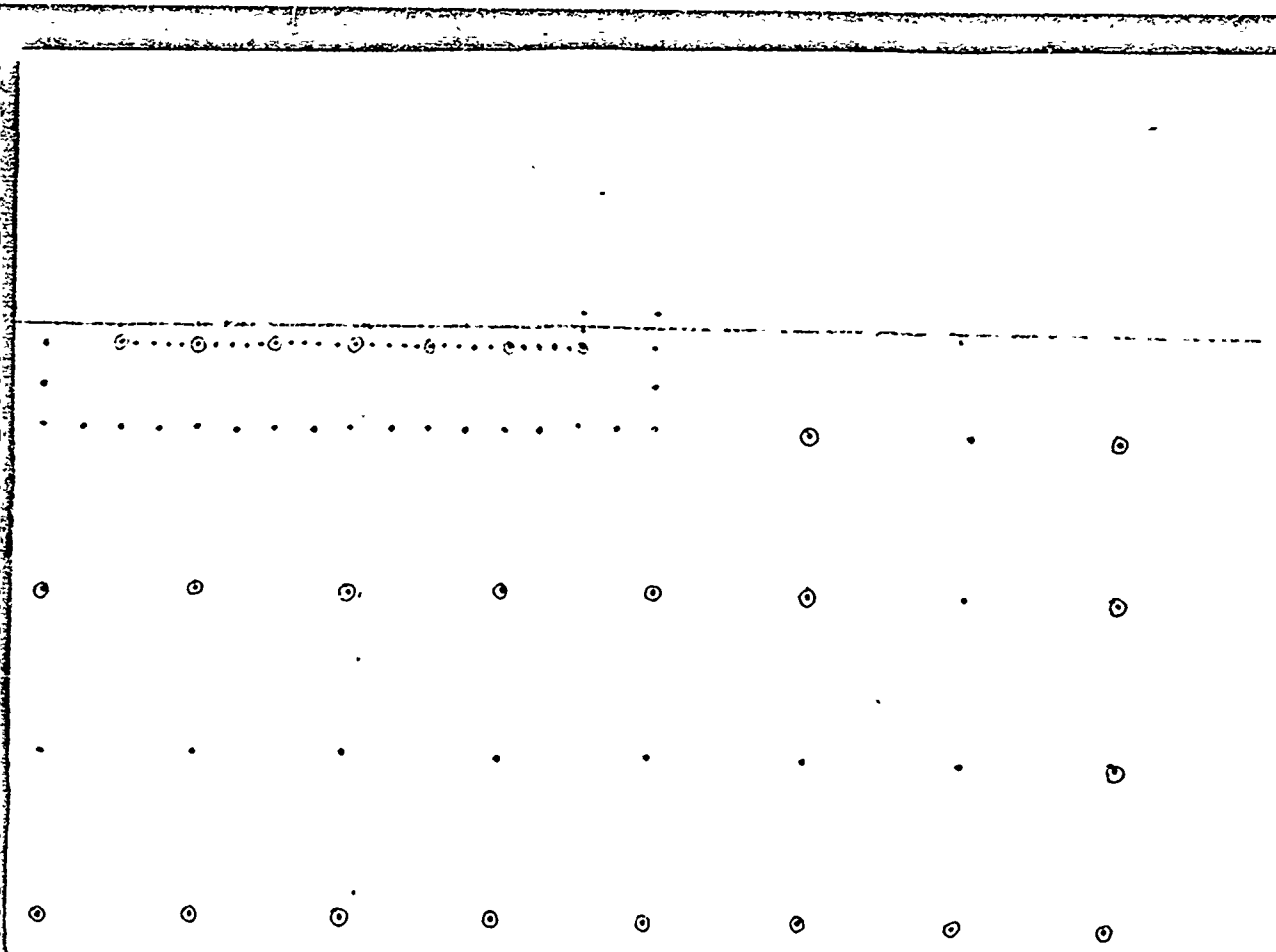
T.G.Mast

Cine-Camera (64 fr/sec)

▲ 100 ft. Wind Mast

| Square | Perpe dista edge c |
|---|---|
| X* | |
| Y* | |
| Z* | |
| N | |
| O | |
| P | |
| Q | |
| R | |
| S | |
| T | |

* Inner Grid



SCALE

1 in. = 50 yd.

order)

es

J2, K2, L2
I4, J4, L4,
57, D7, J7,
L9, B10,
10, L10, B11,
12, I12, J12,

POSITION SPACING

| Square | Perpendicular distance from edge to grid center | Pan spacing | Plate and slide spacing |
|---|---|---|---|
| | yd. | yd. | yd. |
| X* | 5 | 10 | — |
| Y* | 15 | 5 | 5 |
| Z* | 25 | 5 | 5 |
| N | 40 | 10 | 10 |
| O | 50 | 5 | -- |
| P | 75 | 5 | 25 |
| Q | 100 | 12.5 | — |
| R | 150 | 50 | 50 |
| S | 200 | 50 | — |
| T | 250 | 50 | 50 |

* Inner Grid

4

(1)

TEST DIVISION
DIRECTORATE OF DEVELOPMENT
CHEMICAL WARFARE LABORATORIES
Army Chemical Center, Maryland

CMLRD-CW-D(T) 3 April 1957

AMENDMENT II

Test Directives for
Field Tests 1781 through 1801
Field Tests 1802 through 1822

AMENDMENT III

Test Directives for
Field Tests 1823 through 1843

The directives are amended as follows:

III. METEOROLOGICAL REQUIREMENTS.

No precipitation; wind speed at 2 m. height, between 4 and 12 m.p.h.; wind direction for each munition functioned at the 100-ft. height, between 165° and 207°.

VI. PLAN OF TEST.

A. Procedure.

Each of the tests functioned at ground level and at the 50-ft. height will be conducted at M field on a sampling grid which will be laid out as described in diagram A and B. The tests functioned at the 100-ft. height will be conducted at the Aberdeen Proving Grounds on a sampling grid which will be laid out as shown in diagram C, attached hereto.

B. Chemical Data.

The chemical data for each test functioned at the 100-ft. height is amended as follows:

1. Liquid Sampling.

Sampling pans (400) utilizing hexylene glycol as an absorbent will be positioned on a level surface of the ground at each position, as shown in diagram C. The method of analysis will be the THB method.

2. Impaction Sampling.

Vertical plates (19) at the 18-in. height

will be positioned as shown in diagram C.

3. Particle Spectrum Sampling.

Vertical (192) and horizontal (192) slides will be positioned on the grid as shown in diagram C. The vertical slides will be positioned at the 18-in. height.

4. Analysis of Agent Filling.

A 10-ml. sample of the agent in each munition will be submitted to Chemical Test Branch for agent purity examination. If this is not feasible then a sample of the filling batch will be submitted.

Concurred in:

Harold L. Gotoff
Chief, Field Operations Branch

Submitted by:

Dwight H. Shaw

Concurred in:

Abraham Koblin
Chief, Chemical Test Branch

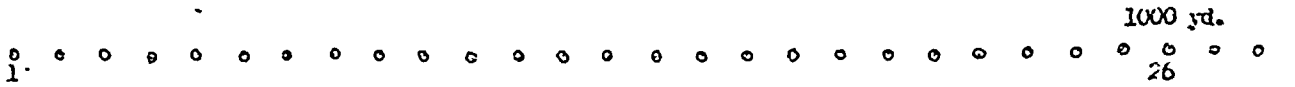
Recommending approval:

Scott D. Thayer
Chief, Planning & Evaluation Branch

APPROVED:

CHARLES E. MILLER
Chief, Test Division

DIAGRAM C

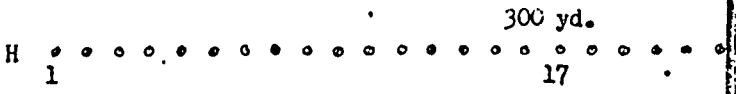




56

47

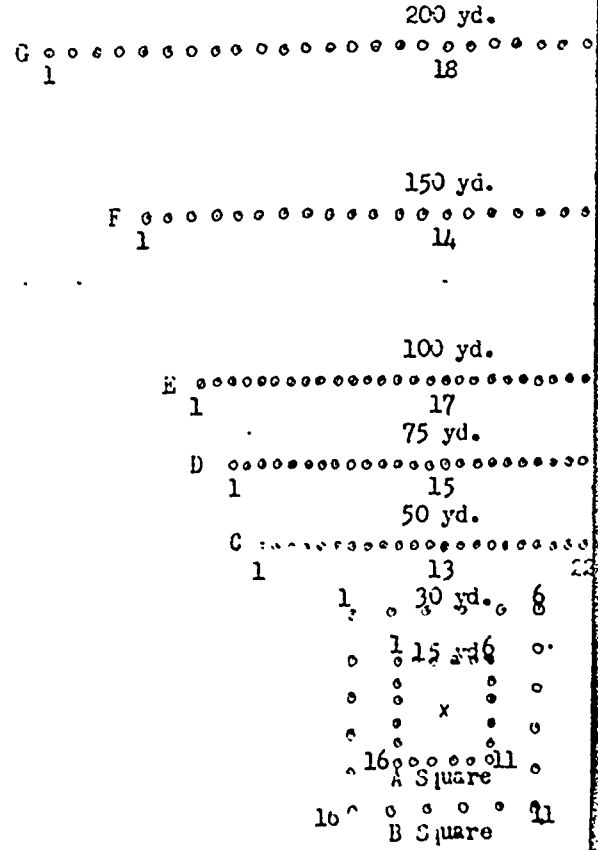

3

45

41

33




LEGEND:

× - Ground Zero

⊗ - Meteorological Mast

⊙ - Sampling Station
Pans on all positions
Horizontal slides
Vertical slides
Vertical plates
} Positions 1 through 6 on B Square and at all positions on line E, F, H, J and L

5

33

26

31

26

22

SCALE:

1 in. = 50 yd.

SPACING:

A - 6 yd.
B - 12 yd.
C - 5 yd.
D - 5 yd.
E - 5 yd.
F -7.5 yd.
G -7.5 yd.
H - 10 yd.
I - 10 yd.
J -12.5 yd.
K - 15 yd.
L - 15 yd.

6

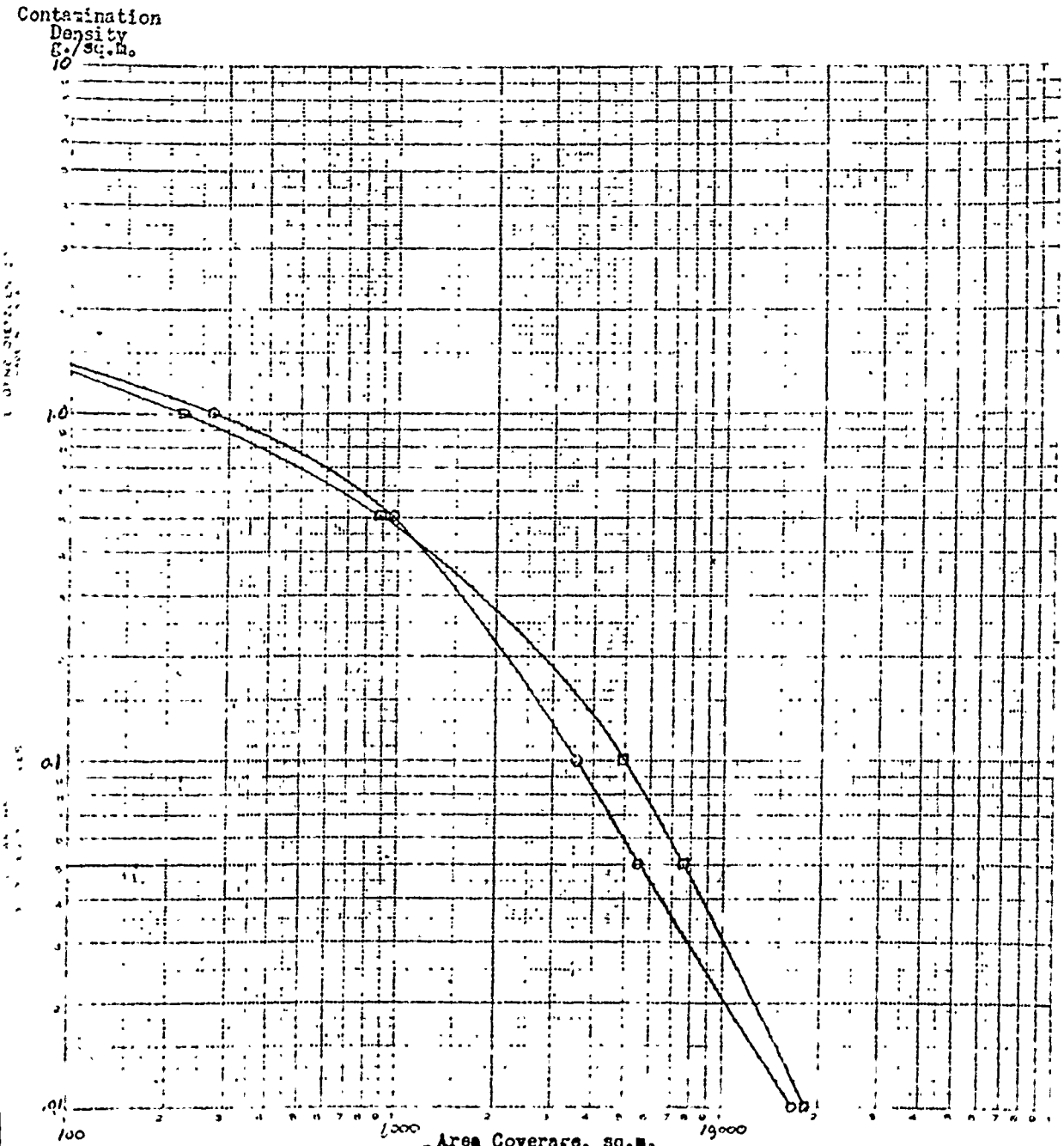
## APPENDIX B

SAMPLE AREA COVERAGE CURVES MEASURED BY GROUND DEPOSITION

Fig. 1, Dynamic Firing Vs Static for the 2/1 Ratio Trials
Fig. 2, Dynamic Firing Vs Static for the 18/1 Ratio Trials
Fig. 3, Bis Filled Vs VX
Fig. 4, Ground Burst Vs Airburst for the 2/1 Ratio Trials
Fig. 5, Ground Burst Vs 50-ft. Burst for the 18/1 Ratio Trials
Fig. 6, Ratios of 2/1 Vs 18/1 for Ground Burst Trials
Fig. 7, Ratios of 2/1 Vs 18/1 for Static Fired Trials
Fig. 8, Ratios of 2/1 Vs 18/1 for Dynamic Fired Trials

FIGURE 1

Area Coverage by Ground Deposition
Dynamic Fired Vs Static for the 155-mm. Shell
Equipped with a 2/1 Ratio

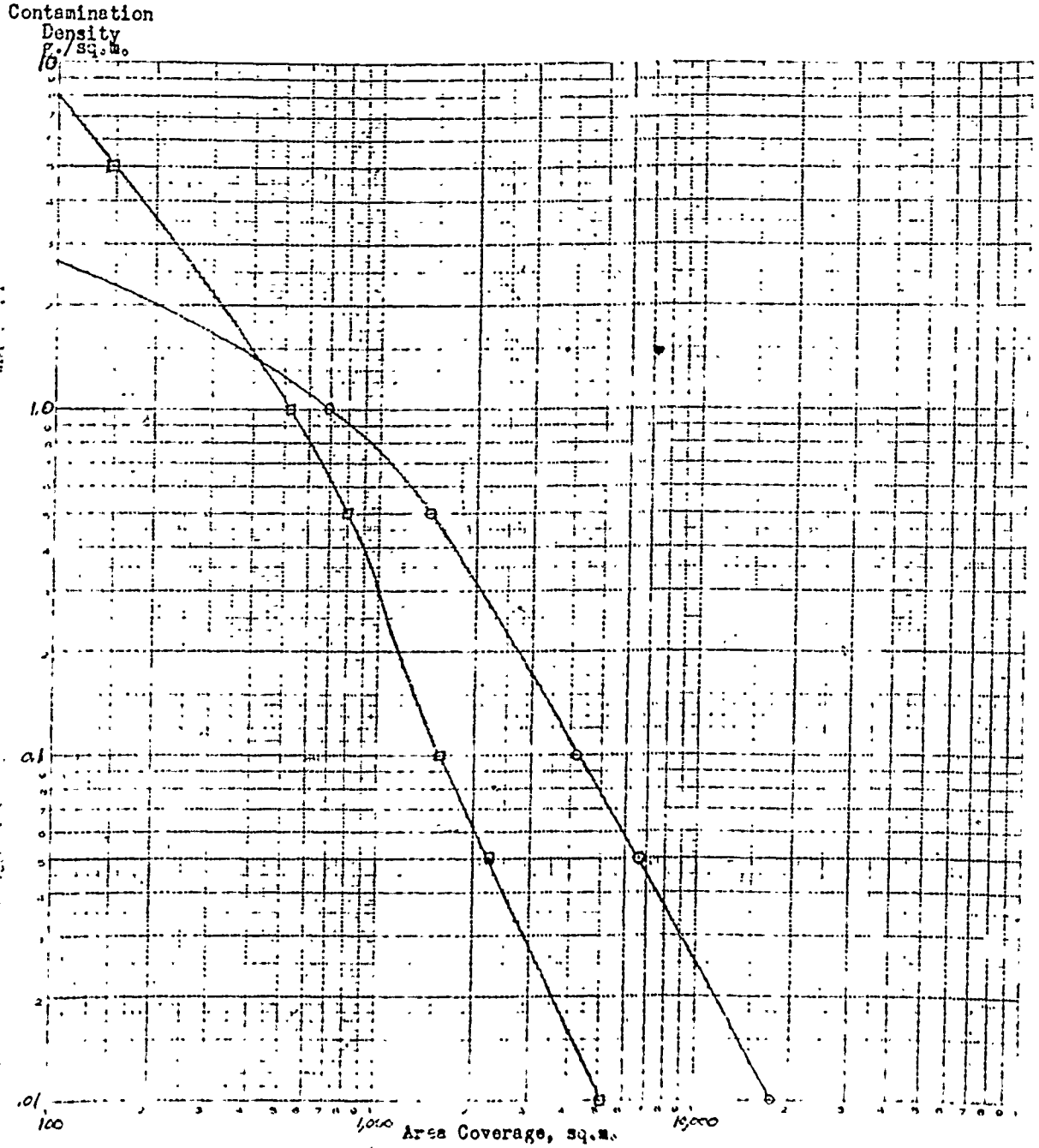



⊙ Dynamic Fired, 2/1 Ratio, 50-ft. Burst, 7 m.p.h. Wind.

⊡ Static Fired, 2/1 Ratio, 50-ft. Burst, 8 m.p.h. Wind.

FIGURE 2

Area Coverage by Ground Deposition
Dynamic Fired Vs Static for the 155-mm. Shell
Equipped with an 18/1 Ratio

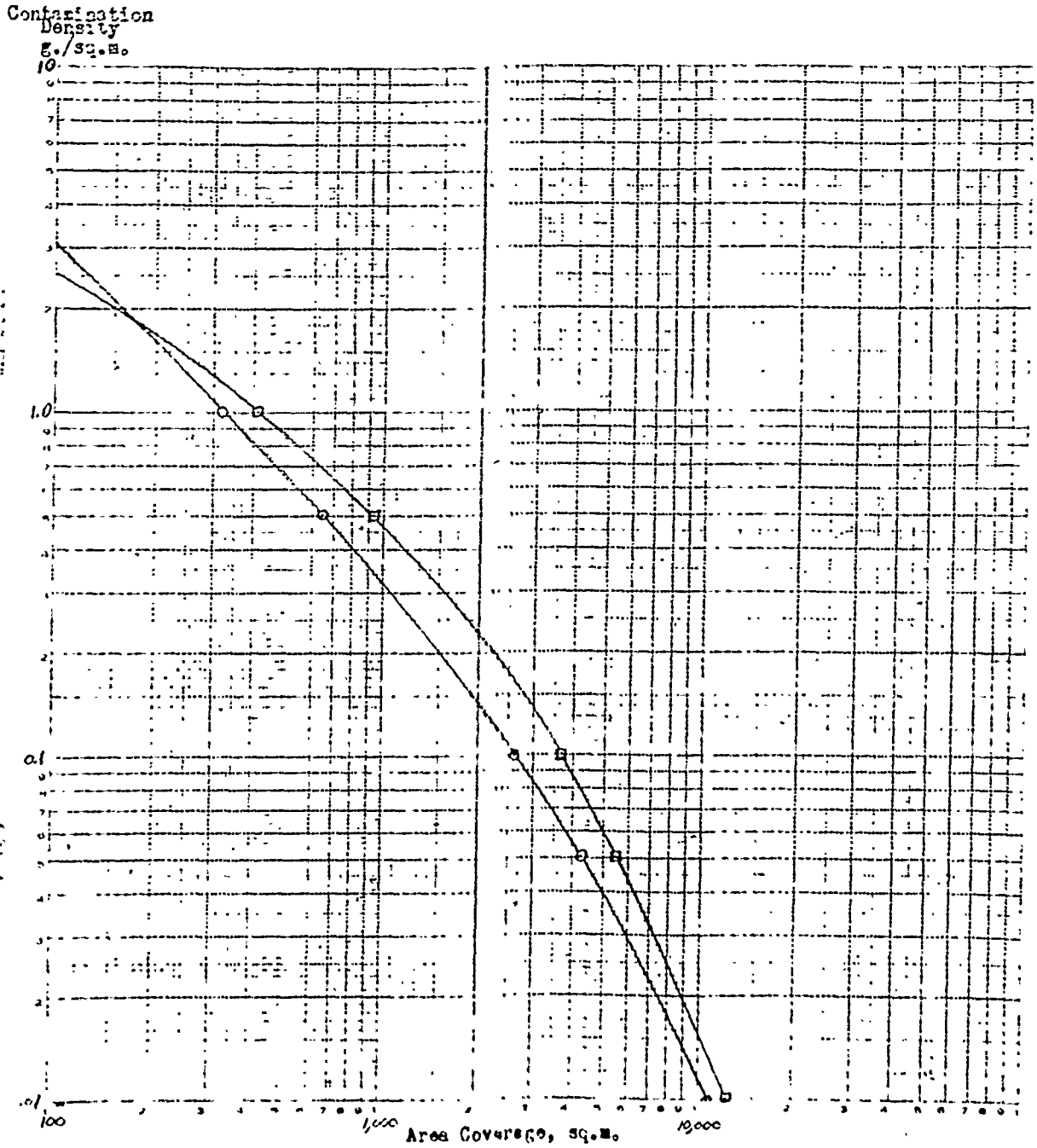



⊙ Dynamic Fired, 18/1 Ratio, 50-ft. Burst. 6 m.p.h. Wind.

⊡ Static Fired, 18/1 Ratio, 50-ft. Burst, 7 m.p.h. Wind.

FIGURE 3

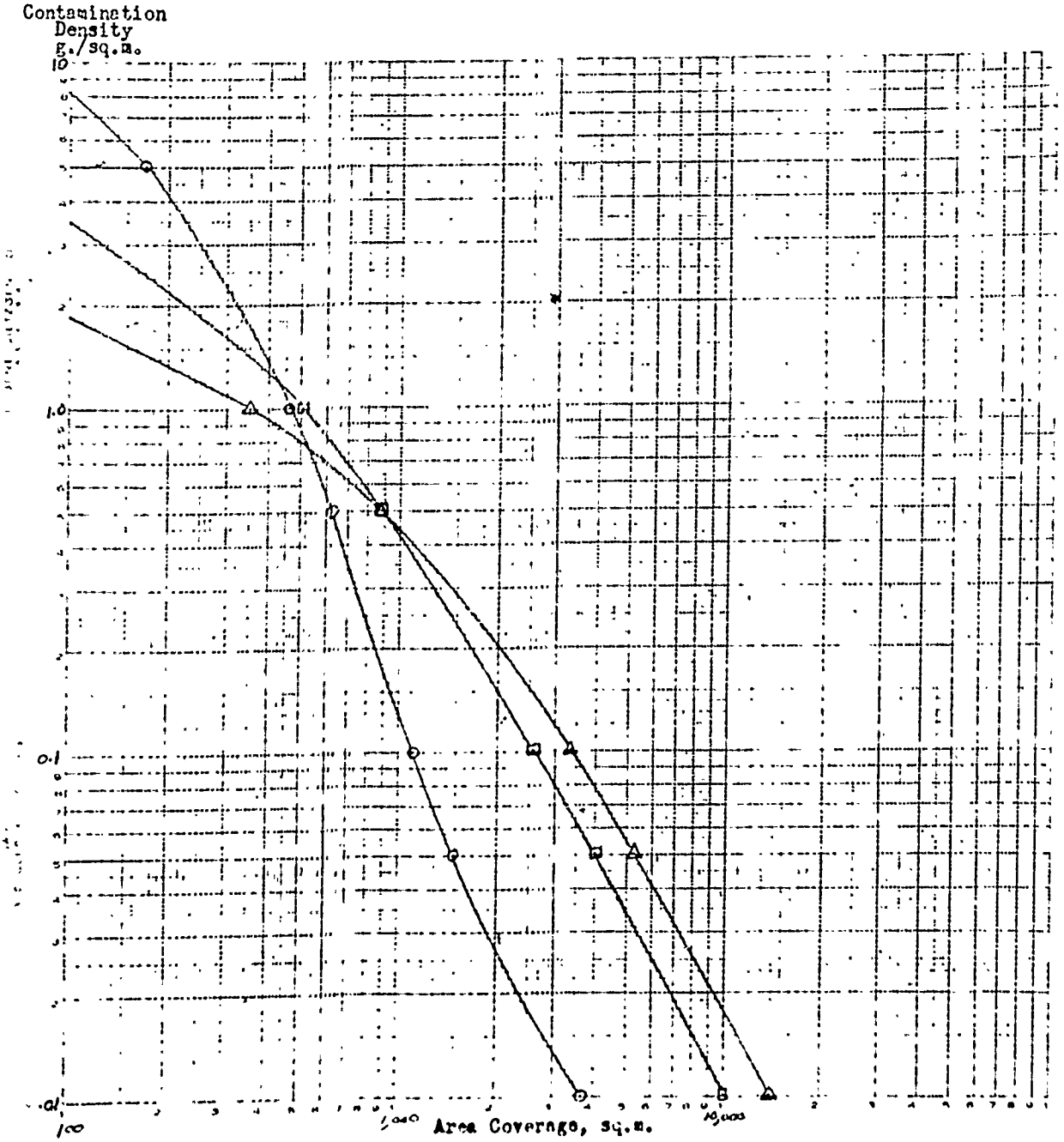
Area Coverage by Ground Deposition
Bis-Filled Vs VX for the 155-mm. Shell




○ Bis-Filled, Dynamic Fired, 50-ft. Burst, 2/1 Ratio, 6 m.p.h. Wind.
□ VX-Filled, Dynamic Fired, 50-ft. Burst, 2/1 Ratio, 6 m.p.h. Wind.

FIGURE 4

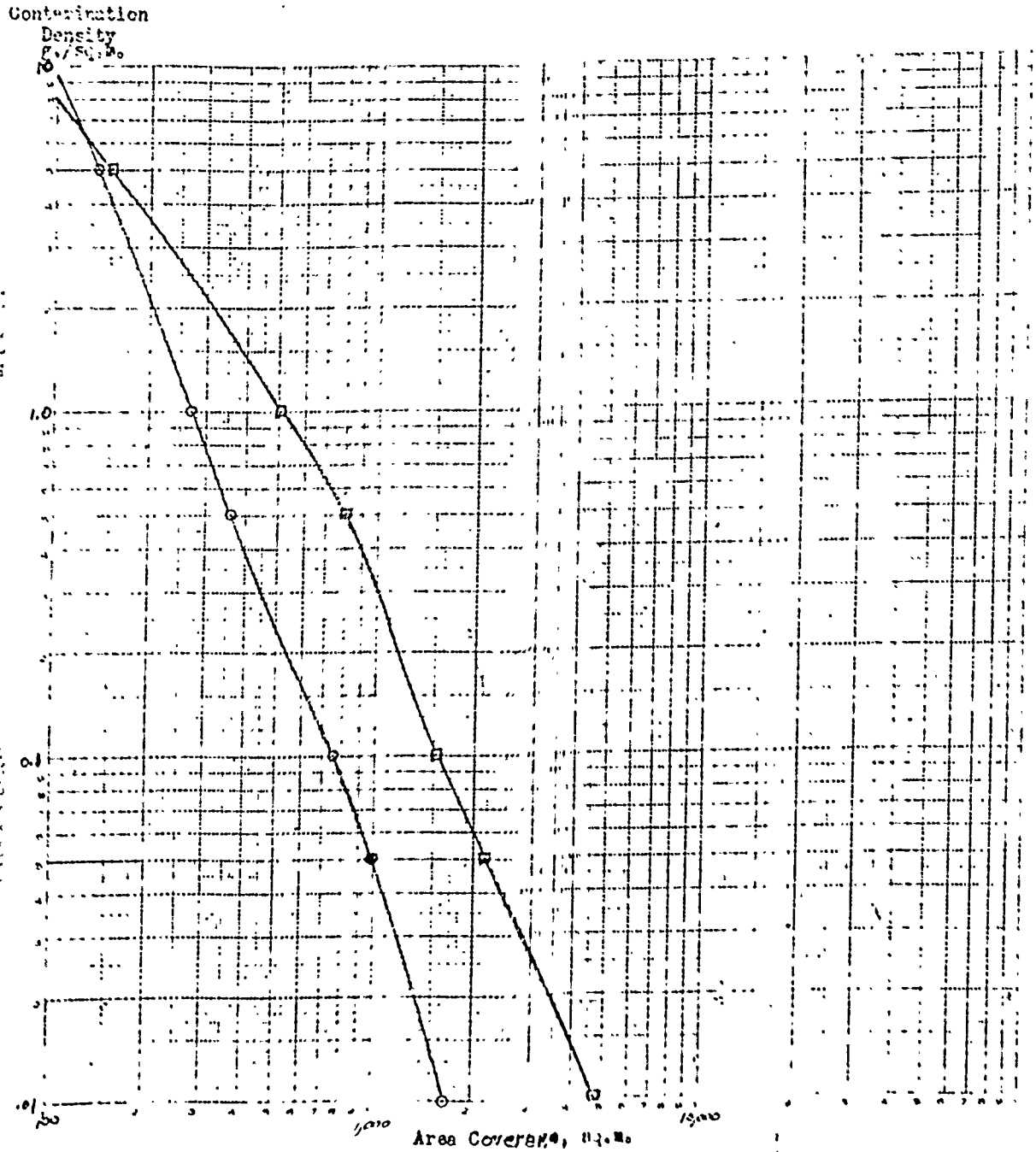
Area Coverage by Ground Deposition
Ground Burst Vs Airburst for the 155-mm. Shell
Equipped with a 2/1 Ratio




○ Ground Burst, 2/1 Ratio, 3 m.p.h. Wind.
□ 25 ft. Burst, 2/1 Ratio, 7 m.p.h. Wind.
△ 50 ft. Burst, 2/1 Ratio, 8 m.p.h Wind.

FIGURE 2

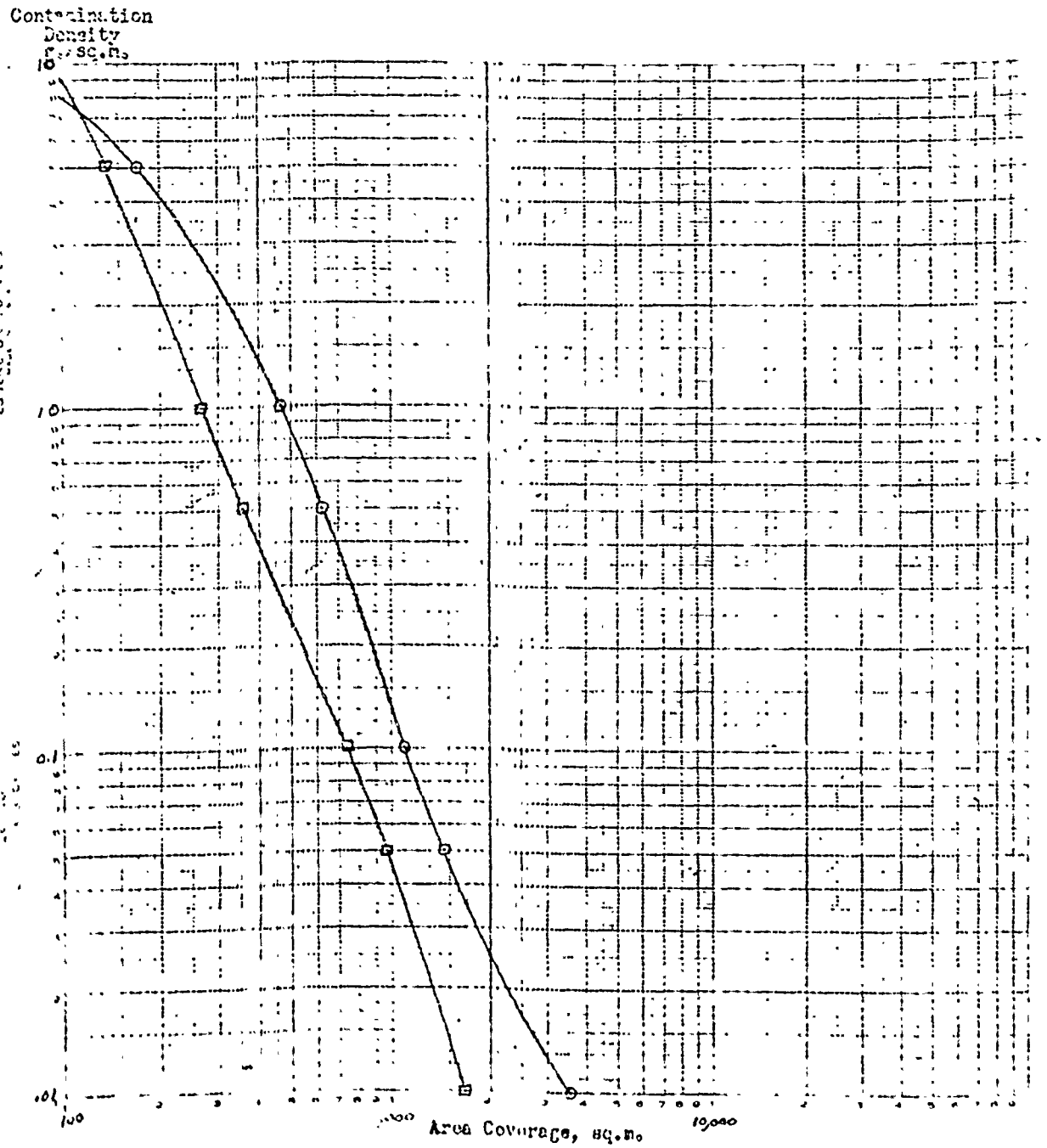
Area Coverage by Ground Deposition
Ground Burst Vs 50 ft. Burst for the 155-mm. Shell
Equipped with an T"/1 Ratio




⊙ Ground Burst, 18/1 Ratio, Static Fired, 2 m.p.h. Wind
⊡ 50 ft. Burst, 10/1 Ratio, Static Fired, 7 m.p.h. Wind

FIGURE 6

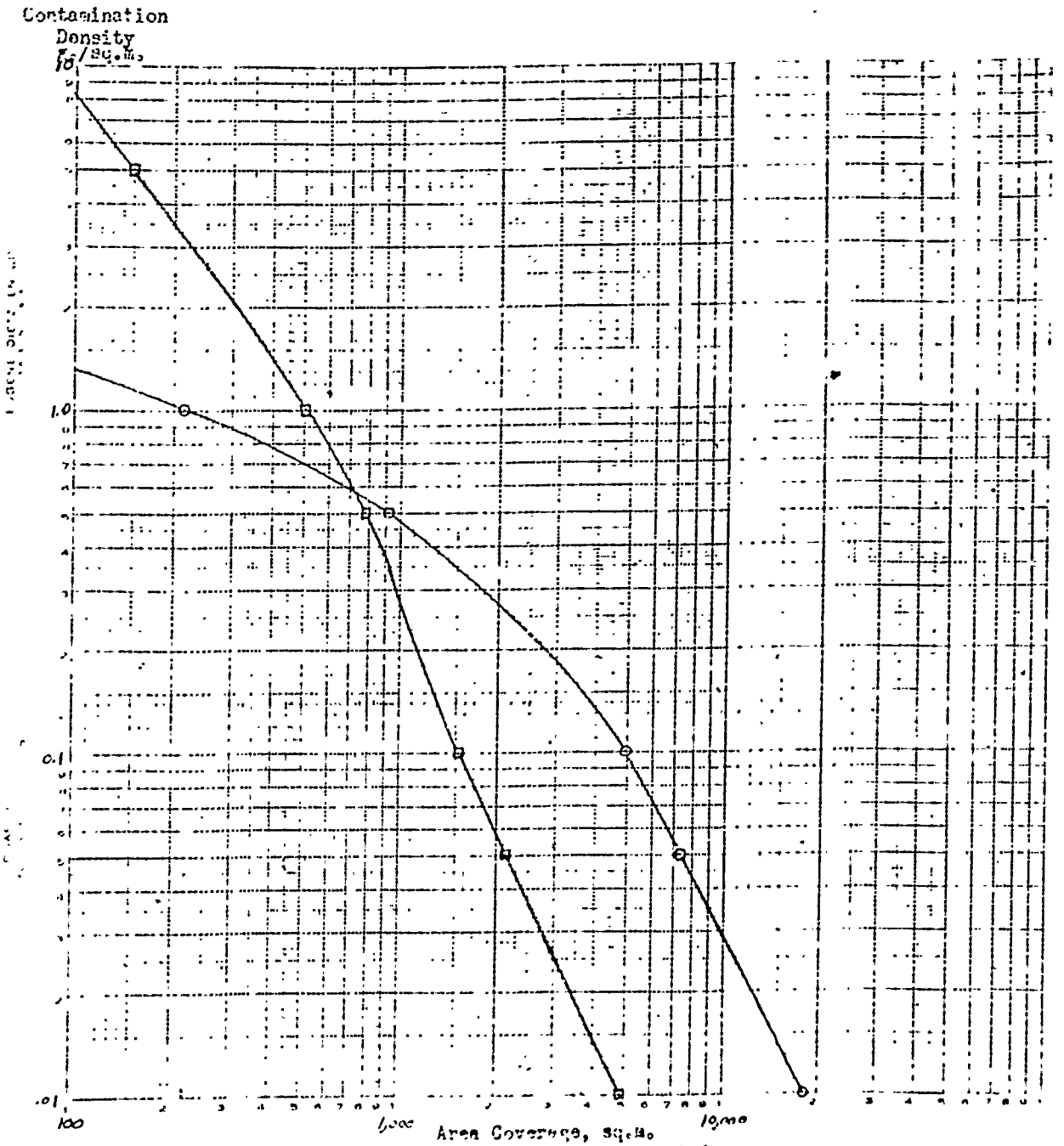
Area Coverage by Ground Deposition
Ratios of 2/1 Vs 13/1 for the Ground Burst 155-mm. Shell




⊙ 2/1 Ratio, ground burst, Static Fired, 3 m.p.h. Wind.
⊡ 13/1 Ratio, ground burst, Static Fired, 2 m.p.h. Wind.

FIGURE 7

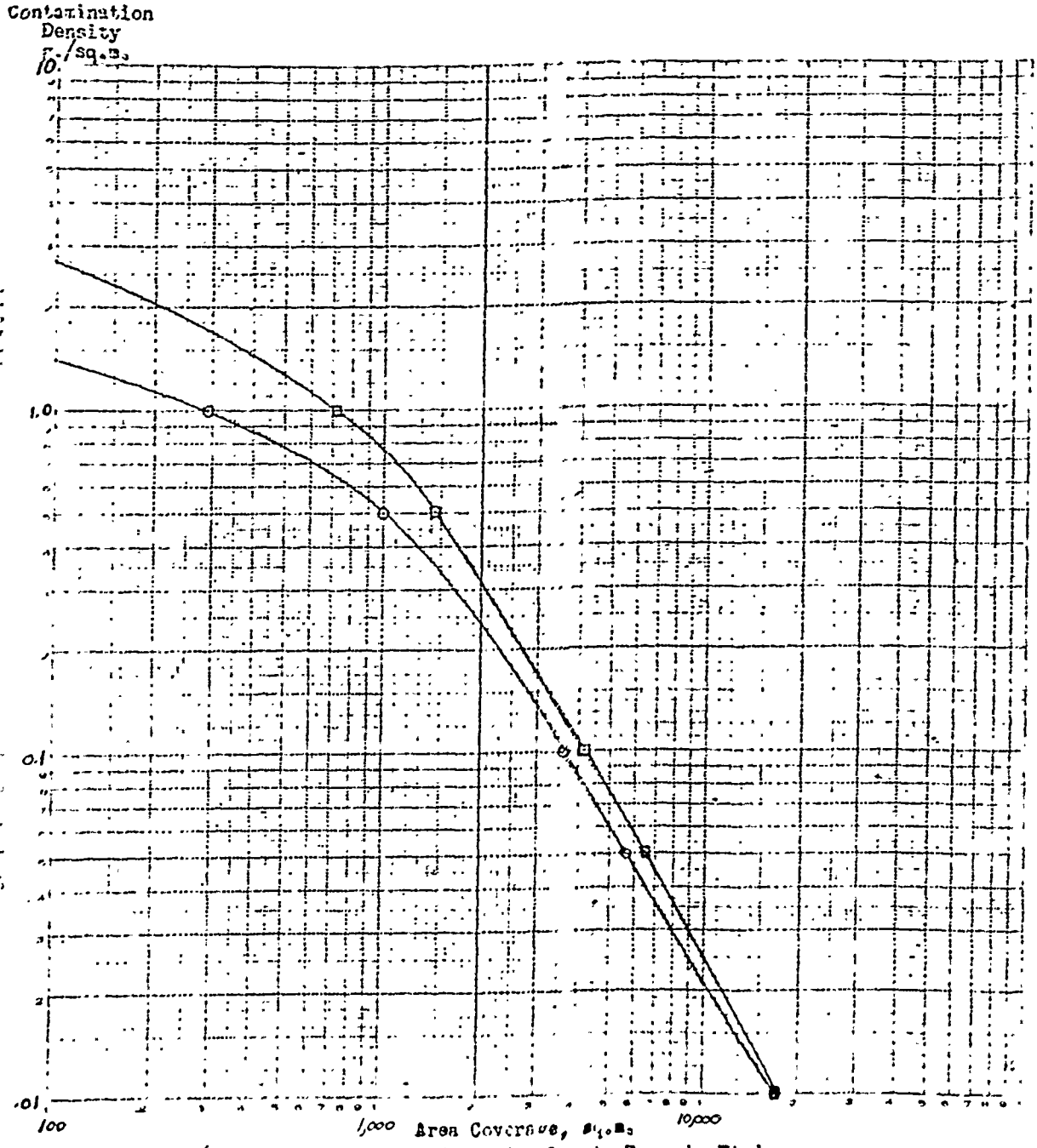
Area Coverage by Ground Deposition
Ratios of 2/1 Vs 18/1 for the Static Fired 155-mm. Shell




⊙ 2/1 Ratio, Static Fired, 50-ft. Burst, 8 m.p.h. Wind.
⊡ 18/1 Ratio, Static Fired, 50-ft. Burst, 7 m.p.h. Wind.

FIGURE 2

Area Coverage by Ground Deposition
Ratios of 2/1 Vs 16/1 for the Dynamic Fired 155-mm. Shell




⊙ 2/1 Ratio, Dynamic Fired, 50-ft. Burst, 7 m.p.h. Wind.
⊡ 16/1 Ratio, Dynamic Fired, 50-ft. Burst, 6 m.p.h. Wind.